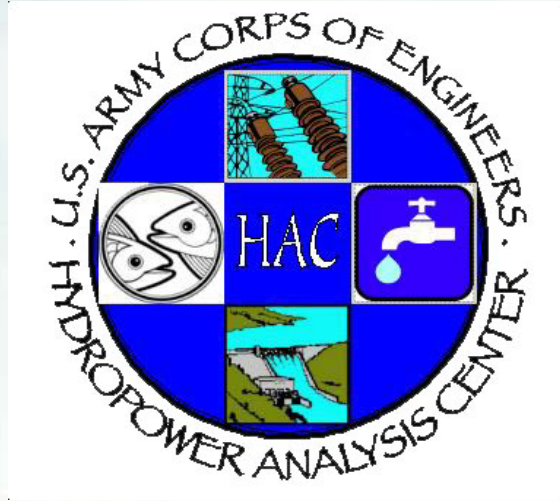


Economics of Chief Joe Turbine Replacement



Corps of Engineers Center of Expertise for Hydropower Analysis & Economic Evaluation

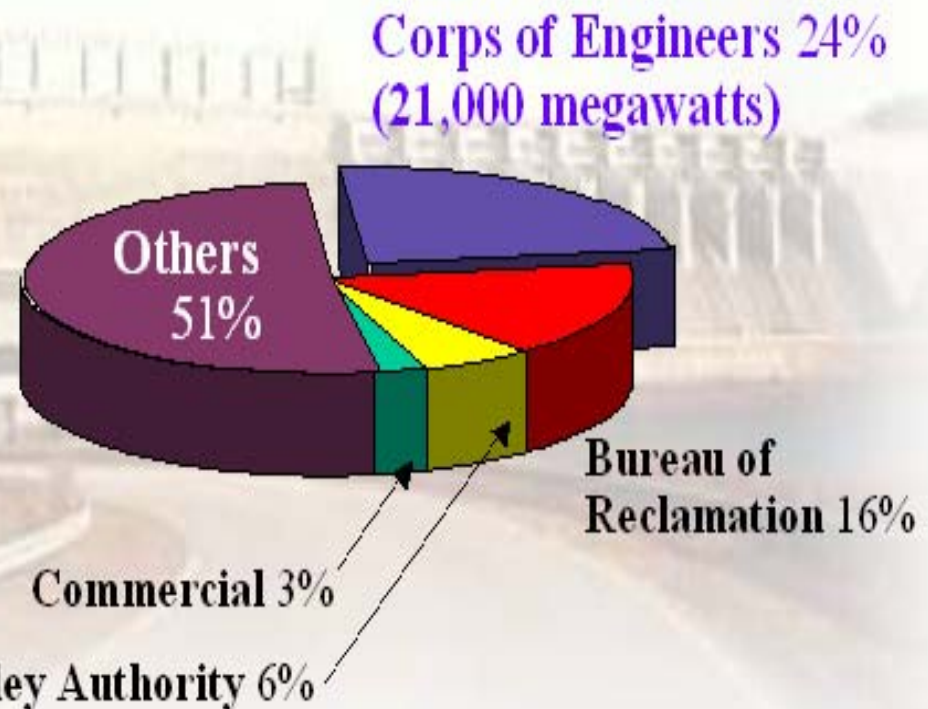
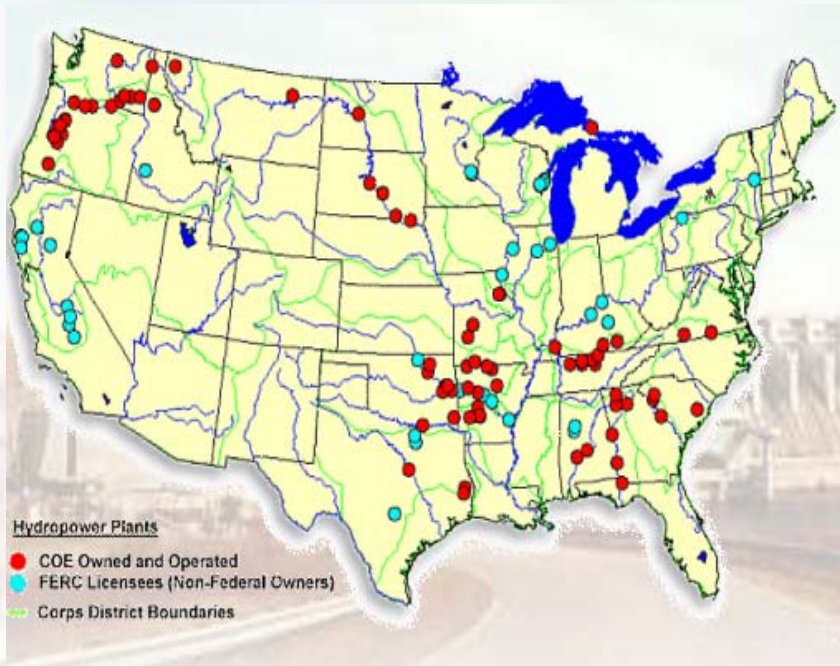


**US Army Corps
of Engineers.**

**Water Management Division
Power Branch
Portland, Oregon**

The Corps and Hydropower

Hydro represents 13% of US Electrical Power.
The Corps has an \$18 billion investment in hydropower facilities (75 plants; 350 generating units)



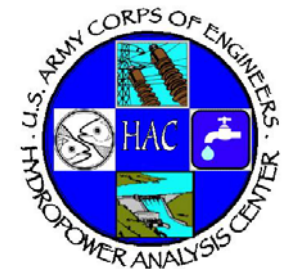
HAC Roles & Capabilities

The HAC has over 50 years of experience in :

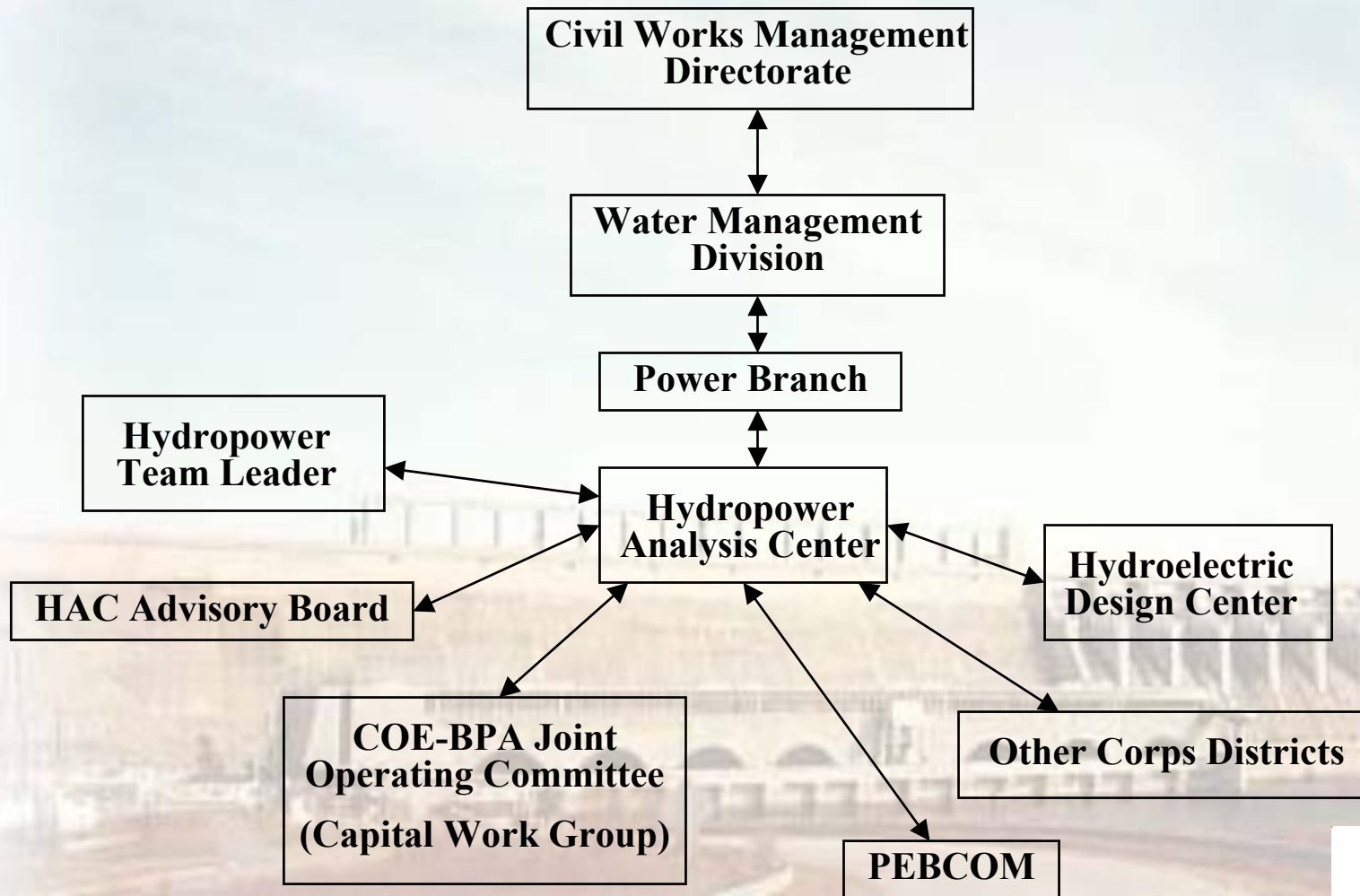
- **Powerplant sizing, upgrades, and rehabilitation**
 - **River system analysis**
 - **Cost allocation and storage reallocation**
 - **Power value and benefit computations**
 - **Environmental and other powerplant studies**
-
- **Staff is cross-trained in the power industry & familiar with stakeholders in all regions**
 - **Works closely with 16 districts, 4 PMA's, HQUSACE**
 - **Helps the COE meet its hydropower functions efficiently**
 - **Support USA assistance to other countries (e.g., China, South Korea, Nigeria, Mozambique, etc.).**



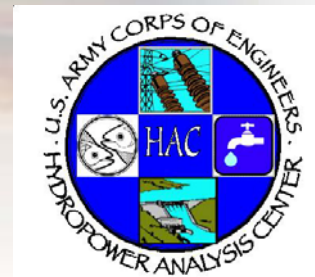
**US Army Corps
of Engineers.**



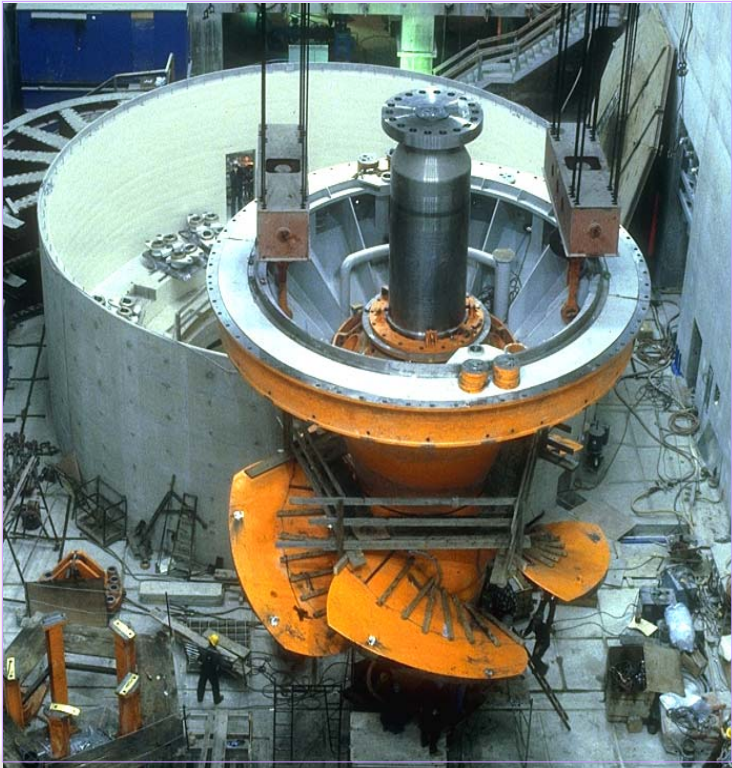
Organization and Affiliations



**US Army Corps
of Engineers.**



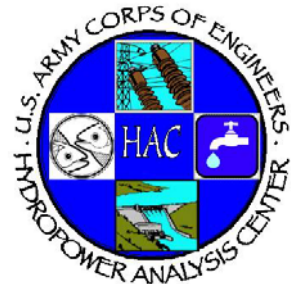
Economics of Chief Joseph Turbine Replacement



- *Available Energy*
- *Turbine Performance Data*
- *Power System Modeling*
- *Economic Analysis*



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Welcome to the TEAM

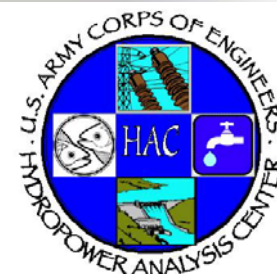
(Turbine Energy Analysis Model)
Version 1.0



Continue



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of Engineers.**

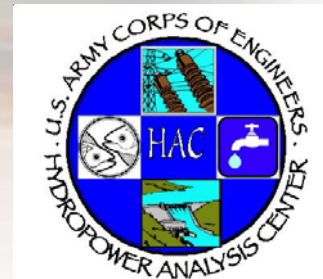


Turbine Energy Analysis Model (TEAM)

- **Unit Water Allocation Model (1 to 30 Units)**
- **Flexible & Portable**
- **Weekly Time-steps with Three Sub-periods**
- **Concurrent Weekly Execution**
- **Built on Standard MS Office software (no compilers!!!)**
- **Uses MS Excel Spreadsheet Features with VBA (Visual Basics for Applications)**
- ***Gets the job done!***



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Turbine Energy Analysis Model (TEAM)

Microsoft Excel - 050329_1445_RUN01_CHJ

File Edit View Insert Format Tools Data Window Help Acrobat

NYRS =Water_MonthlyIF59

Run ID: RUN01_CHJ
Macro Initiated: 29 Mar 2005 14:45
File saved as 050329_1445_RUN01_CHJ.xls by TEAM
Total Run Time: 00:03:44

View TEAM Documentation

Years of Monthly Data: 50
Select First Year to Run: 28-29
Select Last Year to Run: 77-78

Run TEAM

First Year Index: 1
Number of years to run: 50
Periods per Year: 52

RUN STATUS
Run Done

Project Under Study: Chief Joseph Run 1: Base Case - Existing Units
Enter New Run ID: CHJ
Enter Output (Sheet) Prefix: CHJ
Print Detailed Unit Output? No
Print Quick Unit Output? No
Print Table Output (No Sub-Periods)? No
Print Old Debug? No
Run Sub-Periods? Yes
Print Status Messages? Yes

Output Sheets
Not Available for Runs greater than 20 years in Length

CHJ_SP Sheet Exists!
CHJ_HLH Sheet Exists!
CHJ_LLH Sheet Exists!
CHJ_SubPer_Sum Sheet Exists!

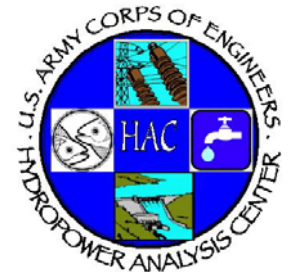
Input Data Sheets (Only Change if You Change Input Sheet Names)
Unit Performance: Unit_Performance
Unit Operations: Unit_Operations
Monthly Water Data: Water_Monthly
Weekly Water Data: Water_Weekly
Sub-Period Water Data: Sub_Periods
Sub-Period Weekly Factors: Sub_Period_Week
Sub-Period Monthly Factors: Sub_Period_Month

Control TEAM_Documentation Unit_Operations Unit_Performance Water_Monthly Water_Weekly Sub_Period_Monthly_Factors Sub_Period_Weekly_Factors Sub_Pe

Ready NUM

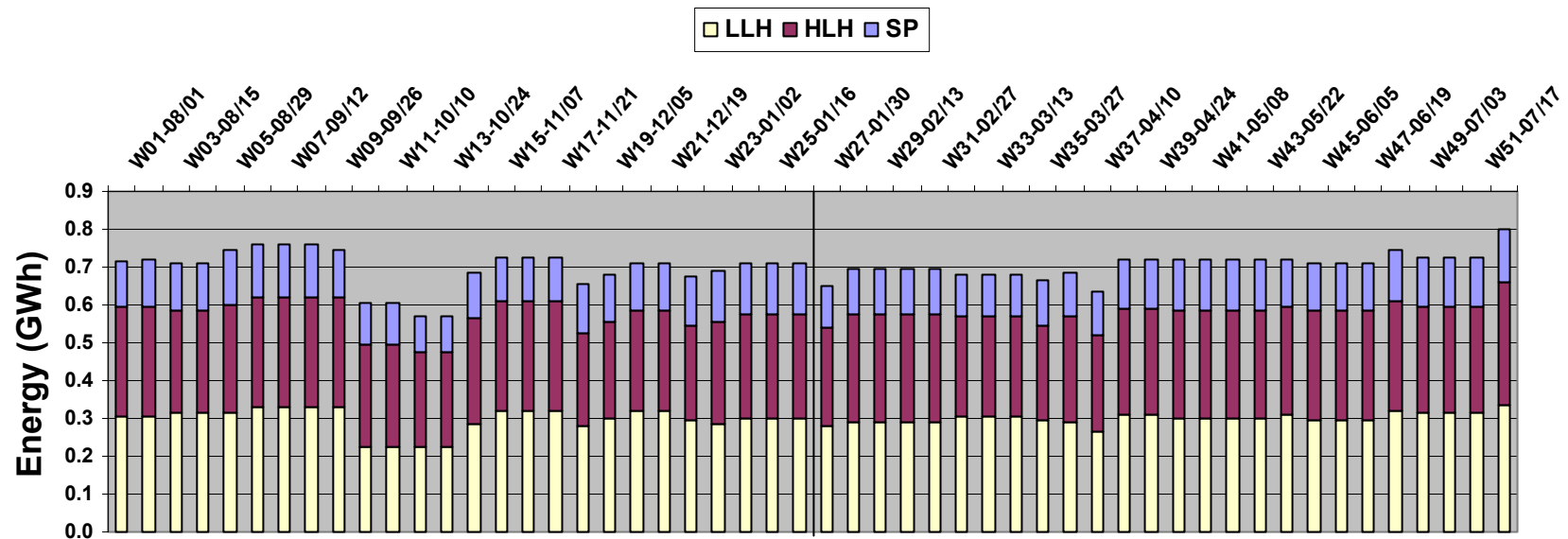


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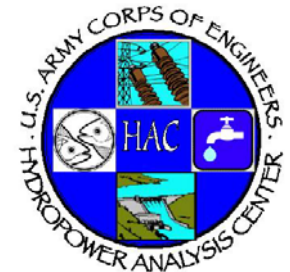


Turbine Energy Analysis Model (TEAM)

Alternative: R02_CHJ_01 - Base: R01_CHJ
Average Change in Weekly Energy (GWh)

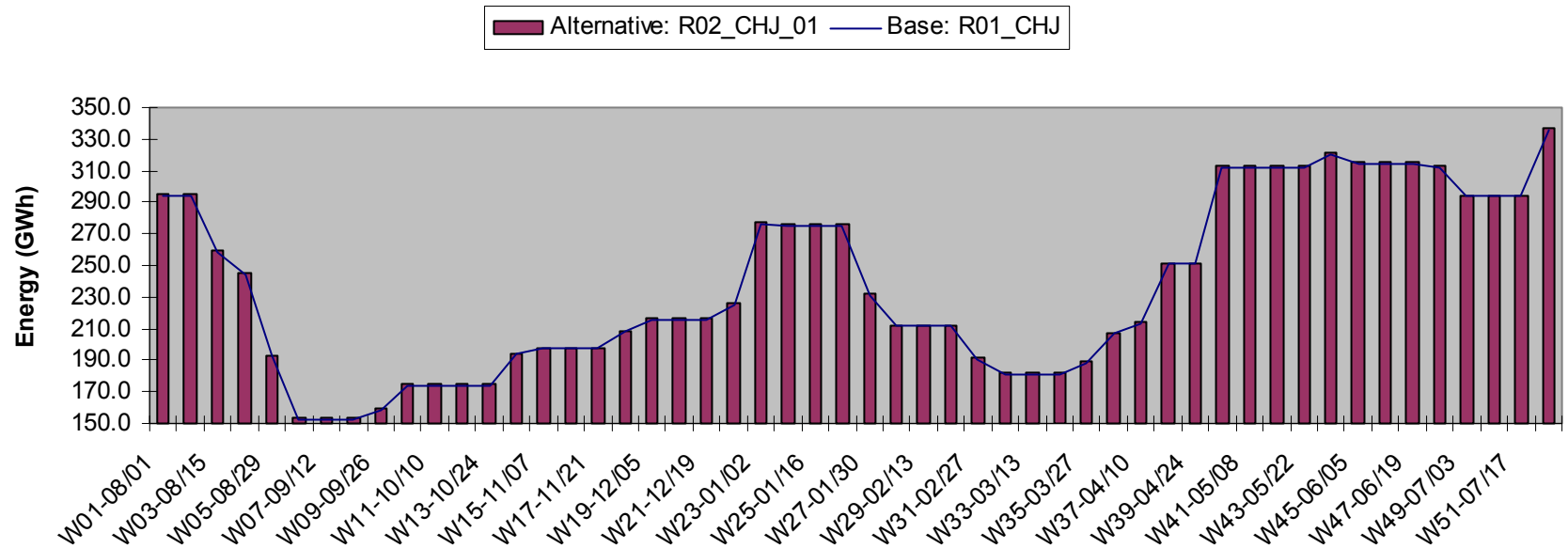


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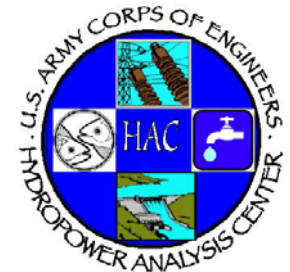


Turbine Energy Analysis Model (TEAM)

Average Total Weekly Generation
Average Annual Gen - Alt: 12351.2 GWh Base: 12315.0 GWh Net Change: 36.3 GWh

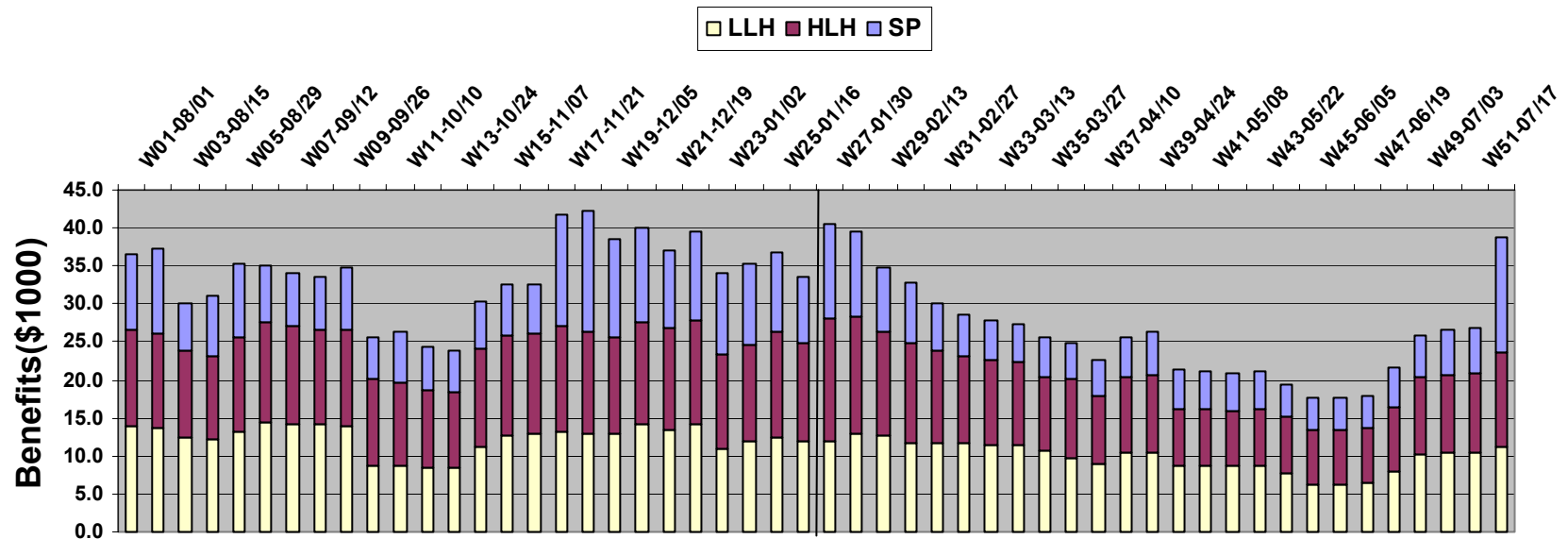


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of Engineers.**

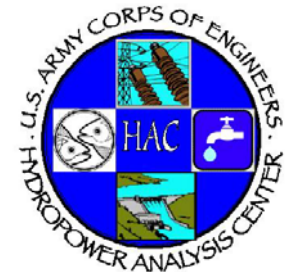


Turbine Energy Analysis Model (TEAM)

Alternative: R02_CHJ_01 - Base: R01_CHJ
Average Change in Weekly Benefits (\$1000)



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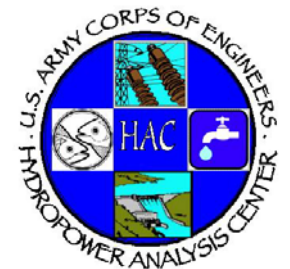


Chief Joseph Economic Analysis

- **Consider a Range of Alternatives**
- **Determine the Optimal Number of units to Replace**
- **Justify Replacement Using An Incremental Analysis**
- **Perform Sensitivities to Refine Analysis**
- **Document Investment Decisions**

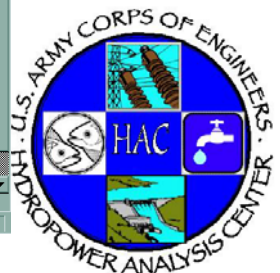


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of Engineers.**



Chief Joseph Economic Analysis

Microsoft Excel - Chief Turbines Econ Analysis with RefurbCosts												
File Edit View Insert Format Tools Data Window Help Acrobat												
K33 =												
A	B	C	D	E	F	G	H	I	J	K	L	M
1												
2	Chief Joseph: Summary of Turbine Replacement Scenarios w/ Refurbish Cost for Original Units not Replaced											
3												
4	IRR, NPV, B:C Ratio for Different Number of Units Upgraded				Incremental IRR, NPV, B:C							
5												
6	Units Upgraded	IRR	NPV using	B:C Ratio using	Change in	IRR	NPV	B:C Ratio				
7			FedDisc% & Inflation	FedDisc% & Inflation	Units Upgraded		FedDisc% & Inflation	FedDisc% & Inflation				
8			(1000s)	(1000s)			(1000s)					
9					0 to 1	20.2%	\$4,475	1.70				
10	1	20.2%	\$4,475	1.70	1 to 2	26.2%	\$5,534	2.19				
11					2 to 3	35.8%	\$7,207	3.18				
12	2	22.5%	\$10,009	1.90	3 to 4	36.0%	\$6,291	3.24				
13	3	25.3%	\$17,216	2.20	4 to 5	32.4%	\$5,456	2.90				
14	4	26.9%	\$23,507	2.37	5 to 6	25.0%	\$3,811	2.10				
15					6 to 7	26.0%	\$3,778	2.29				
16	5	27.6%	\$28,963	2.44	7 to 8	26.0%	\$2,999	2.19				
17	6	27.3%	\$32,774	2.39	8 to 9	22.2%	\$2,145	1.84				
18	7	27.1%	\$36,552	2.38	9 to 10	14.5%	\$407	1.13				
19	8	27.1%	\$39,551	2.36	10 to 11	10.5%	(\$651)	0.80				
20					11 to 12	9.3%	(\$762)	0.73				
21	9	26.7%	\$41,696	2.32	12 to 13	11.9%	(\$206)	0.91				
22	10	25.9%	\$42,102	2.21	13 to 14	10.0%	(\$566)	0.76				
23	11	24.8%	\$41,451	2.09	14 to 15	8.9%	(\$668)	0.70				
24	12	24.1%	\$40,689	2.00	15 to 16	4.7%	(\$1,431)	0.45				
25	13	23.6%	\$40,483	1.94								
26	14	23.0%	\$39,917	1.88								
27	15	22.5%	\$39,249	1.82								
28	16	21.9%	\$37,818	1.75								
29	Applied Rates:	5.4% =IDC Rate		3.0% =InflationRate			13.000% =FedDiscountRate					
30												
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Chief Joseph Economic Analysis

QUESTIONS??



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